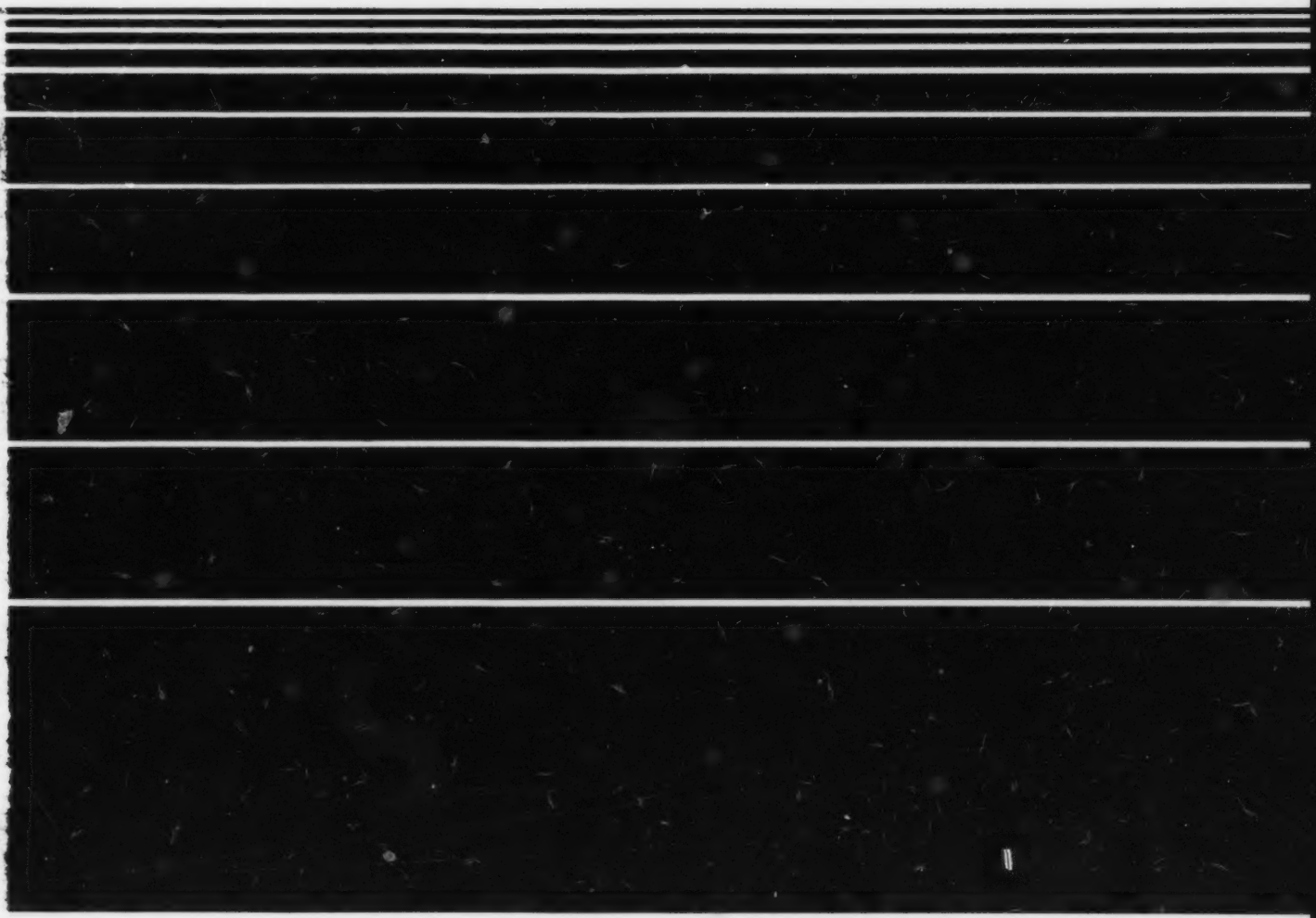

Manitoba
Environment
and Workplace
Safety and Health

TOTAL SUSPENDED PARTICULATE AND LEAD CONCENTRATIONS IN THE WESTON SCHOOL AREA OF WINNIPEG, JANUARY 1984 - APRIL 1985

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ABSTRACT

Concentrations of lead and total suspended particulate (T.S.P.), in the vicinity of Weston School, were investigated during the period of January 1984 to April 1985 by Environmental Management Division, Air Standards and Studies Section. High volume air samplers were located on the roof of the school and at ground level adjacent to the Logan Avenue and Quelch Street. Total suspended particulate concentrations, on several occasions, exceeded the Manitoba Air Quality Objectives and Guidelines at both sampling locations whereas lead concentrations were below the criteria level. Ground level concentrations of lead and T.S.P. were significantly higher than roof top concentrations indicating that vehicular emissions are most likely responsible for the contaminants being monitored. Both ground level and roof top concentrations of lead and T.S.P. were found to be significantly influenced by wind direction during the sampling period. The highest concentrations of both pollutants were observed during easterly wind flows. Logan Avenue, a major traffic route, is located northeast of the monitoring sites. Comparisons were also made between other urban Winnipeg sites. Results indicated that concentrations are positively correlated to traffic flow. This correlation indicates that ground level monitoring provides the most accurate indications of the concentrations of pollutants emitted by motorized vehicles.

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I INTRODUCTION

Vehicles utilizing leaded fuel and the secondary lead smeltering industries are the prime emitters of lead into the atmosphere. Lead enters the human body through ingestion and inhalation with subsequent absorption into the blood stream and distribution to all body tissues. It has been well established by clinical, epidemiological and toxicological studies that exposure to lead will adversely effect human health (Jaworski, 1978).

The Manitoba Air Quality Guideline (M.A.Q.G.) for lead-in-air is 5 micrograms per cubic meter ($\mu g/m^3$) of air when measured as a 24-hour average. This guideline is designed to protect human health (Environmental Management Division, 1982).

Total suspended particulate (T.S.P.) is defined as particulates, either solid or liquid phase, whose geometry allows them to be suspended in ambient air. These particules remain suspended in air and can easily be inhaled. Major sources of this pollutant are road dust, agricultural and industrial activities. The Manitoba Air Quality Objectives (M.A.Q.O.) for T.S.P. are presented in Table 1.

Health concerns have been raised in recent years concerning the concentrations of lead occurring in the Weston School area in the City of Winnipeg (Jones and Wotton, 1983 and Wotton, 1980). In response to these concerns the Environmental Management Division, Air Standards and Studies Section, set up high volume air samplers atop Weston School and at ground level to determine the content of lead in ambient air. T.S.P. concentrations were also included in this study. Ambient concentrations of T.S.P. are required for the calculations of

lead concentrations. This study utilizes data collected between January 1984 and April 1985. Four sites were also chosen from various urban Winnipeg areas as background sites. These sites are part of the Federal Government's National Air Pollution Surveillance (N.A.P.S.) monitoring program, introduced into Manitoba in 1970, to routinely monitor urban air quality.

The prime objectives of this study were:

1. to determine ambient concentrations of lead and T.S.P. in the vicinity of Weston School and compare these values to the Manitoba Air Quality Objectives and Guidelines;
2. to compare lead and T.S.P. concentrations between roof top and ground level sites at Weston School;
3. to determine possible source emitters of lead and T.S.P. by correlation of concentration versus wind direction at Weston School;
4. to compare ambient concentrations of lead and T.S.P. in the vicinity of Weston School to other urban areas of the city.

II MANITOBA AIR QUALITY OBJECTIVES AND GUIDELINES

The Manitoba Government has adopted criteria for various air pollutants. These criteria are known as the Manitoba Air Quality Objectives and Guidelines (Environmental Management Division, 1982). The maximum levels of total suspended particulate and lead are presented in Table 1. The establishment of objectives and guidelines are based upon two assessment levels:

1. Maximum Acceptable Level (M.A.L.)

   This level is deemed essential to provide adequate protection for soils, water, vegetation, materials, animals and visibility. Personal comfort and well being are also included under this guideline.

2. Maximum Desirable Level (M.D.L.)

   This level defines the long term goal for air quality and could provide the basis for an anti-degradation policy for the unpolluted portions of the Province and for the development and application of control technology. At this level, there would be no detectable adverse biological effect on any receptor.

Table 1: Manitoba Air Quality Objectives and Guidelines for total suspended particulate and lead.

Contaminant	Time Period Measured	Max. Acceptable Level (M.A.L.)($\mu g/m^3$)	Max. Desirable Level (M.D.L.)($\mu g/m^3$)
Total suspended particulate	24-hour average	120	*
	annual geometric mean	70	60
Lead	24-hour average	5	*

* No objective or guideline value set

III MONITORING LOCATIONS

Weston School, located at the intersection of Logan Avenue and Quelch Street, was the site of stations coded CB3 and CB5 (Figure 1). This location is situated approximately 200 meters south of a secondary lead smelter and adjacent to a high traffic area (11,041 vehicles, 7 a.m.-7 p.m.).

Site CB3 was located on the roof top of the school approximately 11 meters above ground level. Site CB5 was situated at ground level, approximately 1.5 meters from the intersection.

The background sites, coded 9102, 9118, 9119 and 9120 are part of the N.A.P.S. sampling program and represent a variety of urban Winnipeg areas.

Site 9102 was located at 2120 Portage Avenue between Duffield Street and Woodlawn Street. The sampler is 3 meters above ground level and 20 meters south of Portage Avenue, a major traffic artery (35,512 vehicles, 7 a.m.-7 p.m.).

Site 9118, was located at 299 Scotia Street (at Jefferson Avenue) and represents a residential area with an average traffic flow of 716 vehicles between 7 a.m. and 7 p.m. The sampler is situated 4 meters above ground level.

Site 9119 was located in the downtown area at 65 Ellen Street. This sampler is 3 meters above ground level and 50 meters from Notre Dame, a major traffic artery (9,728 vehicles, 7 a.m.-7 p.m.).

Figure 1: Sampling sites CB3 ad CB5.

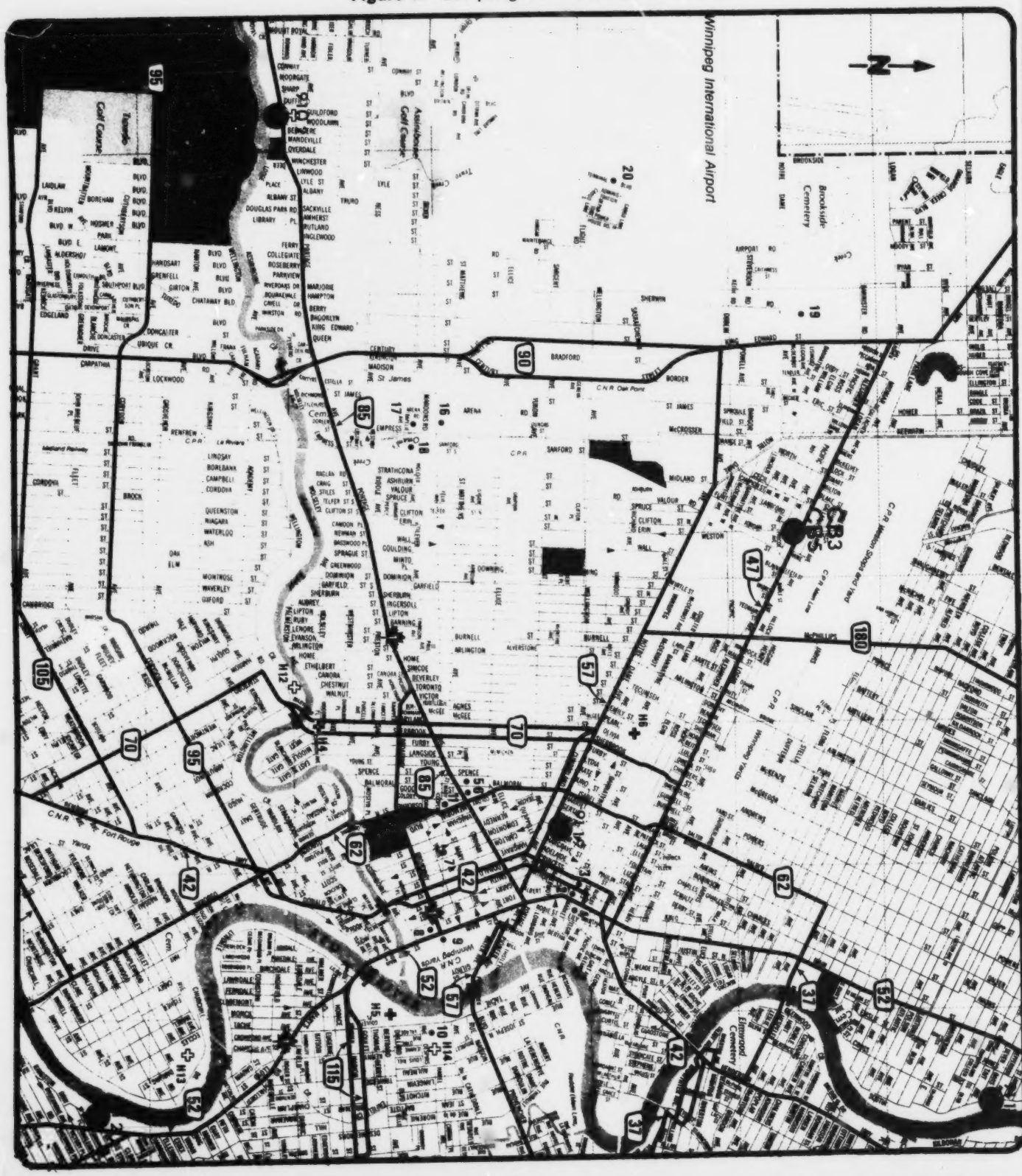
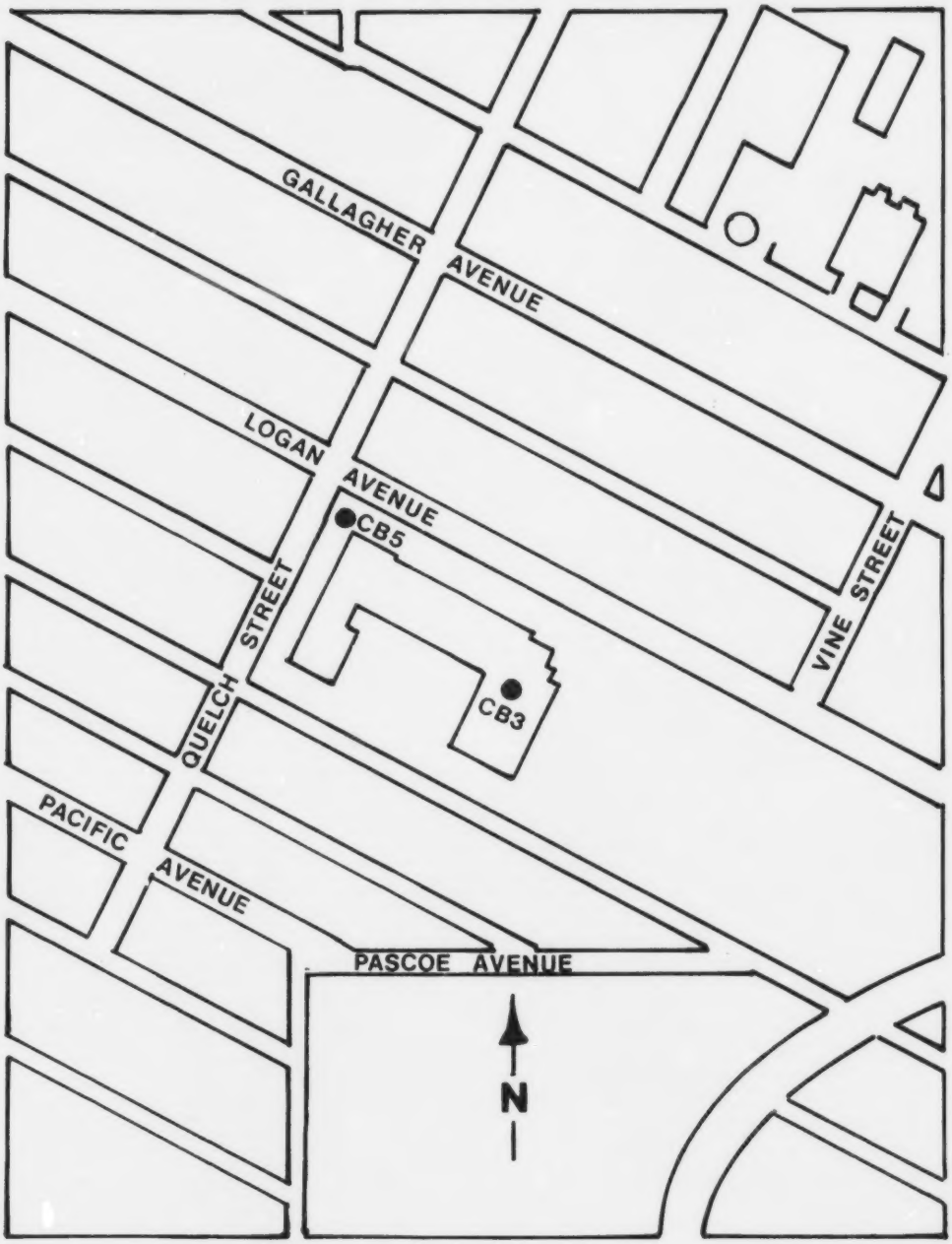


Figure 2: N.A.P.S., CB3 and CB5 sample site locations.



Site 9120 also represent a residential area. It was located at 604 St. Mary's Road, 70 meters north of the road and 4 meters above ground level (18,042 vehicles, 7 a.m.-7 p.m.).

A map showing the locations of the sites within the City of Winnipeg is represented in Figure 2 and traffic levels are presented in Table 2.

Table 2: Traffic levels

Location	Year	Count[1]
9102 - Portage Avenue at Woodlawn Street	1980	35,512
9118 - Scotia Street at Jefferson Avenue	1976	716
9119 - Ellen Street and McDermot Avenue	1982	9,728
9120 - St. Mary's Road at Mager Street	1984	18,042
CB3, CB5 - Logan Avenue at Quelch Street	1984	11,041

1. Counts represents the 12 hour daily avaerage between 7 a.m.-7 p.m.

IV METHODOLOGY

1. FIELD SAMPLING

Sampling for total suspended particulates and lead was performed in accordance with Environment Canada reference method "Standard Reference Method for the Measurement of Suspended Particulate in the Atmosphere (High Volume Method)", EPS Report No. 1-AP-73-2 (January, 1973). Briefly stated, the high volume air sampler draws air into the housing at a flow rate of 1.13 to 1.70 cubic meters per minute for a 24-hour period. During this time particles with an aerodynamic diameter size range of 0.1 to 100 microns become impacted on to the filter.

The collected samples were submitted to the W. M. Ward Technical Services Laboratory for specific analysis of lead and T.S.P. Lead-in-air analysis involved sample digestion with subsequent detection utilizing atomic absorption spectrometry as outlined by Monkman, J. L. et al (1972). T.S.P. results were obtained by gravimetric analysis as presented in the Air Pollution Control Directorate (1973).

Two types of filters were utilized; glass fiber and teflon. As the methodology of analysis is identical for both types, the type of filter used in each instance is not specified.

2. COMPILATION OF DATA

Total suspended particulate and lead concentrations monitored during the sampling period (January 1984 to April 1985) are shown in Appendices A and B. Appendices C through G contain subsets of

concentrations taken from the main data set. These subsets were created in order to reduce error by maintaining equal sample sizes and common sampling dates for each statistical analysis.

The total suspended particulate and lead-in-air concentrations are integrated 24-hour averages expressed in micrograms per cubic metre of air. These averages have been corrected to reference conditions of 25°C and 101.3 k pascals of pressure.

Meteorological data, used in the air volume correction were obtained from the Winnipeg Weather Office. Prevailing winds sited are for the longest duration within 24-hours.

Traffic levels were supplied by the City of Winnipeg, Streets and Transportation Department.

Preliminary analysis of the data indicated that a transformation was needed to satisfy the statistical requirement of a normal distribution (Remington and Schork, 1970). Total suspended particulate values were transformed using the common logarithm ($Log_{10}X$). Lead Values were transformed using the common logarithm of the value plus one ($Log_{10}(X+1)$).

Various statistical tests were utilized in this study. A paired t-test ($\alpha = 0.05$) was used to compare the concentration of T.S.P. and lead at Weston School sites CB3 and CB5. Analysis of variance, using 95% confidence limits, was applied to wind direction data in the Weston area and on site comparison data. Duncan's Multiple Range Test ($\alpha = 0.05$) was applied to those parameters showing significant differences.

V DISCUSSION OF RESULTS

1. MANITOBA AIR QUALITY OBJECTIVES AND GUIDELINES

A comparison between the M.A.Q.O. and the T.S.P. concentrations obtained from the Weston School area (Table 3) revealed that at site CB3, during the period of January 1984 to July 1984, the Maximum Acceptable Level (M.A.L.) 24-hour average was exceeded 3% of the time. At site CB5 for the period of January 1984 to January 1985 the 24-hour M.A.L. was exceeded 42% of the time, and both the M.A.L. annual geometric mean and the M.D.L. annual geometric mean were exceeded.

A comparison between the M.A.Q.G. and the lead concentrations obtained from the Weston School area (Table 3) indicated that the lead concentrations did not exceed the guidelines on any occasion at either site during the sampling periods.

2. WESTON SCHOOL

A summary of the T.S.P. and lead concentrations for Weston School sites CB3 and CB5 (January 1984 to July 1984 and January 1984 to April 1985, respectively) are presented in Table 4. Total suspended particulate and lead concentrations in the Weston School area were compared. For both sites CB3 and CB5 a significant ($\alpha = 0.05$) difference ($t = 7.07$ and $t = 10.39$, respectively) was noted between the concentrations of T.S.P. and lead. This indicates that the concentrations of T.S.P. and lead that become entrapped on

Table 3: Summary of total suspended particulate and lead exceedences of the Manitoba Air Quality Objectives and Guidelines.

Contaminant	Time Period Measured	Max. Acceptable Level CB3	Max. Acceptable Level CB5	Max. Desirable Level CB3	Max. Desirable Level CB5
Total suspended particulate	24-hour average	1(3%)[1]	39(42%)[1]	*	*
	annual geometric mean	N.A.[2]	E.G.[3]	N.A.[2]	E.G.[3]
Lead	24-hour average	N.E.[4]	N.E.[4]	*	*

1. Number of exceedences (percentage of exceedences)
2. N.A. = not applicable
3. E.G. = exceeded guideline
4. N.E. = no exceedences

Table 4: Summary of total suspended particulate and lead concentrations for Weston School sites CB3 and CB5 (January 1984 to July 1984 and January 1984 to April 1985, respectively).

	CB3 (Roof)		CB5 (Ground)	
Statistic	T.S.P.[1] ($\mu g/m^3$)	Lead ($\mu g/m^3$)	T.S.P.[1] ($\mu g/m^3$)	Lead ($\mu g/m^3$)
Geometric Mean	54	0.26	98	0.58
Standard deviation	1.9	0.15	2.3	0.29
Minimum value	23	0.08	20	0.05
Maximum value	238	0.84	970	2.21
Data range	23-238	0.08-0.84	20-970	0.05-2.21

1. T.S.P. = total suspended particulate

a filter are independent of each other, and most likely originate from different sources.

Comparisons were made between sites CB3 and CB5 regarding T.S.P. and lead concentrations. The data used for these comparisons represents a subset created by selecting common sampling dates (Table 5). Statistical analysis indicates that between sites CB3 and CB5 a significant ($\alpha = 0.05$) difference exists for both T.S.P. ($t = 7.00$) and lead ($t = 4.96$). The ground level site (CB5) has significantly greater concentrations of both pollutants. This indicates that the sources of these contaminants are located near ground level. Thus, the probability of the secondary smelter contributing a significant amount of either contaminant is unlikely. Vehicular traffic appears to be the major source.

3. WIND EFFECTS - WESTON SCHOOL SITES

The influence of wind direction on T.S.P. and lead concentrations was investigated for sites CB3 and CB5, utilizing the four cardinal directions; north, east, south and west (Table 6).

Statistical analysis of site CB5 indicated ambient air concentrations of T.S.P. were not significantly different ($F = 2.15$) at the 95% confidence limit, when considered in relation to wind direction (Table 7). Lead concentrations however, were significantly different ($F = 12.94$) when considered in relation to wind direction. Duncan's multiple range test (Table 7) indicates that lead concentrations obtained during easterly wind flow did not differ significantly ($\alpha = 0.05$) from concentrations obtained during

Table 5: Summary of total suspended particulate and lead concentrations for Weston School sites CB3 and CB5 (common sampling dates).

	CB3 (Roof)		CB5 (Ground)	
Statistic	T.S.P.[1] ($\mu g/m^3$)	Lead ($\mu g/m^3$)	T.S.P.[1] ($\mu g/m^3$)	Lead ($\mu g/m^3$)
Geometric Mean	54	0.23	132	0.58
Standard deviation	1.9	0.15	2.5	0.29
Minimum value	23	0.08	35	0.17
Maximum value	238	0.84	970	2.21
Data range	23-238	0.08-0.84	35-970	0.17-2.21

1. T.S.P. = total suspended particulate

Table 6: Summary of total suspended particulate and lead concentrations for Weston area versus wind direction.

Site and Parameters	T.S.P.[1] ($\mu g/m^3$) West	North	East	South	Lead ($\mu g/m^3$) West	North	East	South
CB3								
Geometric Mean	36	51	79	54	0.20	0.23	0.29	0.23
Standard Deviation	1.6	1.7	1.7	1.7	0.10	0.07	0.07	0.12
CB5								
Geometric Mean	117	166	224	86	0.32	0.70	1.19	0.35
Standard Deviation	2.2	2.2	2.6	1.9	0.12	0.20	0.32	0.12

1. T.S.P. = Total suspended particulate

northerly wind flows. However, they did differ significantly from southerly and westerly wind flow concentrations. The northerly wind flow concentrations did not differ significantly from either westerly or southerly wind flow concentrations.

The only known possible sources of lead emissions, that is located either east or north of the site, is the vehicular traffic utilizing Logan Avenue.

Site CB3 ambient air concentrations of lead were not significantly different ($F = 0.64$) at the 95% confidence limit when considered in relation to wind direction (Table 7). Concentrations of T.S.P. however, did show significant differences ($F = 3.36$). Duncan's multiple rate test (Table 7) indicates that T.S.P. concentrations obtained during easterly wind flows differed significantly from westerly wind flows but, not from northerly or southerly wind flows. The concentrations from northerly, westerly and southerly wind flows did not differ significantly from each other.

It appears that the high traffic areas east of the school produce greater concentrations of T.S.P. than the lower traffic areas west of the school.

In summary, the influence of wind direction on the concentrations of T.S.P. and lead reveal that greater concentrations of lead are present in the northerly and easterly directions, near ground level. From this and previous information it would appear that the lead being monitored at Weston School is emitted primarily by motorized vehicles travelling along Logan Avenue. This concurs with the findings in the report, "Ambient Lead-in-Particulate Survey Around Winnipeg's Secondary Lead Smelters" by Air Pollution Control (1980).

Table 7: Weston School - Comparison and ranks of wind direction influences on concentrations of total suspended particulate and lead.

Station	Contaminant	Significant Differences Per Analysis of Variance F	F 0.95	Rank and Similarity Per Duncan's Multiple Range Test ($\alpha = 0.05$)[1]
CB5	T.S.P.[2]	0	2.95	Identical
	Lead	12.94	2.95	E N S W
CB3	T.S.P.[2]	3.36	2.95	E S N W
	Lead	0	2.95	Identical

1. Directions are ranked from highest to lowest value where E = East, N = North, S = South and W = West.
   Statistically similar directions are underscored.

2. T.S.P. = Total suspended particulates

Total suspended particulate concentrations are significantly greater from an easterly direction than a westerly direction, measured at a height of 11 meters above ground level. Based on the information obtained previously, it would appear that T.S.P. is primarily produced near ground level in high traffic areas.

4. URBAN SITE COMPARISONS

Weston School sites CB3 and CB5 were compared to several other urban Winnipeg sites regarding T.S.P. and lead concentrations (Tables 8 and 9). Statistical analysis of T.S.P. concentrations indicates that a significant difference ($F = 5.41$), at 95% confidence limits, exists between the sites. Duncan's multiple range test (Table 9) indicates that site CB5 does not differ signficantly ($\alpha = 0.05$) from site 9119 but, it does differ significantly from all other sites. Site 9119 differs significantly from site 9118 but does not differ significantly from sites 9102, 9120 or CB3. A ranking of T.S.P. concentrations is presented in Table 9.

The T.S.P. results are in agreement with previous findings. Concentrations of T.S.P. are shown to be primarily correlated to traffic flows when distance from the roadway and height above ground are considered.

Statistical analysis of comparisons between sites regarding lead concentrations indicates a significant difference does not exist ($F = 5.15$). Duncan's multiple range test reveals that lead concentrations at site CB5 are significantly higher then the other sites. No significant difference is indicated between the other sites.

Table 8: Summary of site comparisons for total suspended particulate and lead concentrations.

	Sites					
Statistic	CB3	CB5	9118	9119	9102	9120
Total suspended Particulate						
Geometric Mean	60	182	38	87	54	47
Standard Deviation	2.1	2.4	1.6	1.55	1.3	2.2
Minimum Value	23	88	21	54	37	22
Maximum Value	238	970	67	188	75	187
Lead						
Geometric Mean	0.23	0.70	0.15	0.35	0.23	0.17
Standard Deviation	0.12	0.29	0.10	0.32	0.10	0.10
Minimum Value	0.08	0.17	0.08	0.12	0.06	0.06
Maximum Value	0.44	1.69	0.41	1.51	0.35	0.39

Table 9: Comparison and ranks for urban Winnipeg site comparisons of total suspended particulate and lead

Contaminant	Significant Differences Per Analysis of Variance F	F 0.95	Rank and Similarity Per Duncan's Multiple Range Test (α = 0.05)[1]
T.S.P.[2]	5.41	2.49	CB5 9119 CB3 9102 9120 9118
Lead	5.15	2.49	CB5 9119 CB3 9102 9120 9118

1. Sites are ranked from highest to lowest value. Statistically similar sites are underscored.

2. T.S.P. = Total suspended particulate.

This comparison strengthens the assumption that the samplers are monitoring lead produced primarily by motorized vehicles (none of the reference sites are located near a smelter).

In conclusion, the data presented in this report suggests that roadways can influence the air quality significantly and their effect can best be estimated by sampling in close proximity to these sources.

VII CONCLUSIONS

The following conclusions were drawn on small sample sizes and are based on data obtained during the test period January 1984 to April 1985.

1a. Lead concentrations recorded in the Weston School area did not exceed the Manitoba Air Quality Guidelines.

1b. Total suspended particulate concentrations recorded in the Weston School area, particulary the ground level readings, exceeded the Manitoba Air Quality Objectives on several occasions.

2. Concentrations of lead and T.S.P. that becomes entrapped on a filter are independent of each other.

3. In the Weston School area, significantly greater concentrations of both T.S.P. and lead were obtained from ground level site CB5.

4a. Lead concentrations were significantly different, near ground level, when considered in relation to wind direction. Easterly and northerly flows represent the greatest concentrations.

4b. Easterly wind flow concentrations of T.S.P. were significantly higher than westerly wind flow concentrations when measured at a height of 11 meters.

5. A comparison amoung the urban Winnipeg area sites indicates that the concentrations of T.S.P. and lead are greatest at site CB5. Concentrations of both T.S.P. and lead are correlated to traffic flow and dependent on distance from the roadways and sampling height.

6a. The lead emissions monitored are primarily produced by motorized vehicles. Ground level monitoring provides the best estimates by sampling in close proximity to these sources.

6b. Total suspended particulates are concentrated at ground level and are correlated to traffic flow.

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APPENDICES

Appendix A: Total suspended particulate and lead concentrations for Weston School site CB3, January 1984 - July 1984.

Date of Sample	T.S.P. ($\mu g/m^3$)	Lead ($\mu g/m^3$)	Wind Direction	Wind Speed (Knots/Hour)
84-01-01	67	0.25	East	5
84-01-03	43	0.22	West	10
84-01-06	51	0.30	East	3
84-01-09	26	0.24	West	10
84-01-11	90	0.29	East-North-East	6
84-01-14	48	0.30	East	5
84-01-17	25	0.15	West-North-West	6
84-01-21	63	0.18	East	2
84-01-24	25	0.12	West-North-West	11
84-01-29	24	0.16	South	7
84-02-13	27	0.15	South	6
84-02-18	23	0.25	North	5
84-02-24	95	0.33	East-North-East	9
84-02-28	89	0.46	West	8
84-03-06	116	0.22	North-North-East	5
84-03-13	74	0.22	North-North-East	4
84-03-19	35	0.11	South	9
84-03-25	74	0.12	South-East	8
84-04-18	238	0.44	East	5
84-04-21	87	0.13	South	6
84-04-24	76	0.15	West	7
84-06-20	71	0.18	South-East	7
84-06-23	33	0.14	North-North-West	14
84-06-26	36	0.13	North-North-West	8
84-06-29	90	0.43	South	8
84-07-05	44	0.17	North	18
84-07-08	70	0.51	South	14
84-07-11	23	0.08	West	6
84-07-14	31	0.42	West	10
84-07-20	96	0.84	East	8
84-07-23	50	0.19	North-North-West	15

Appendix B: Total suspended particulate and lead concentrations for Weston School site CB5, January 1984 - April 1985.

Date of Sample	T.S.P.($\mu g/m^3$)	Lead ($\mu g/m^3$)	Wind Direction	Wind Speed (Knots/Hour)
84-01-05	46	0.52	West	10
84-01-11	264	0.86	East-North-East	6
84-01-17	45	0.23	West-North-West	6
84-01-24	52	0.26	West-North-West	11
84-01-29	35	0.19	South	7
84-02-06	57	0.48	South	6
84-02-13	49	0.28	South	6
84-02-18	46	0.50	North	5
84-02-24	693	2.21	East-North-East	9
84-02-28	322	1.22	West	8
84-03-06	330	0.62	North-North-East	5
84-03-13	372	0.77	North-North-East	4
84-03-19	65	0.25	South	9
84-03-25	193	0.24	South-East	8
84-04-18	970	1.69	East	5
84-04-21	237	0.43	South	6
84-04-24	224	0.54	West	7
84-04-27	73	0.55	North-North-East	22
84-04-30	21	0.92	North-West	13
84-05-03	628	1.35	North	4
84-05-06	247	0.83	North-East	9
84-05-09	284	0.63	North-West	5
84-05-12	141	0.86	East	6
84-05-15	222	0.46	West	18
84-05-18	363	0.42	West	13
84-05-21	145	0.13	West	16
84-05-24	184	0.50	North-North-East	23
84-05-27	225	0.51	East-North-East	8
84-05-30	207	0.20	South	11
84-06-02	238	0.24	West	12
84-06-05	244	1.98	North-East	20
84-06-08	65	0.49	West-North-West	16
84-06-11	104	0.23	South	8
84-06-14	269	0.88	South	3
84-06-17	114	0.26	West-North-West	6
84-06-20	82	0.52	South-East	7
84-06-23	281	0.83	North-West	14
84-06-26	97	0.81	North-West	8
84-06-29	108	0.62	South	8
84-07-05	134	0.96	North	18
84-07-08	67	0.39	South	14
84-07-11	88	0.55	West	6
84-07-14	60	0.26	West	10
84-07-17	98	1.02	North-West	5
84-07-20	136	0.65	South-South-East	8
84-07-23	89	0.17	North-West	15

Appendix B continued

Date of Sample	T.S.P.($\mu g/m^3$)	Lead ($\mu g/m^3$)	Wind Direction	Wind Speed (Knots/Hour)
84-07-26	133	1.01	Calm	3
84-07-29	76	0.23	South	21
84-08-01	231	1.24	South	5
84-08-04	105	0.37	South	9
84-08-07	97	0.77	West	3
84-08-10	106	1.22	South-South-East	4
84-08-13	132	0.93	South-South-EAst	7
84-08-16	112	0.53	South	8
84-08-19	87	0.17	South	10
84-08-22	109	10.8	North-North-West	11
84-08-25	107	0.26	South	17
84-08-28	486	0.80	South	7
84-08-31	175	1.06	West-North-West	7
84-09-03	125	0.66	South	4
84-09-06	253	0.77	South-South-East	17
84-09-09	58	0.59	North-North-West	7
84-09-12	57	0.90	East-South-East	4
84-09-15	90	0.70	West	4
84-09-18	173	1.29	West-North-West	7
84-09-21	79	0.87	East-North-East	14
84-09-24	103	1.41	North	10
84-09-27	137	2.00	West	7
84-09-30	93	0.93	North-North-West	5
84-10-03	117	1.38	West	4
84-10-06	174	1.05	South	6
84-10-09	130	0.57	South	7
84-10-12	125	0.71	South	5
84-10-15	46	1.05	North	15
84-10-18	247	2.00	East-North-East	4
84-10-21	28	0.57	North-North-West	7
84-10-24	106	1.15	North	10
84-10-27	29	0.37	North-West	19
84-10-30	112	0.27	West	7
84-11-02	142	0.97	South-East	10
84-11-05	20	1.17	North-North-West	5
84-11-08	64	1.00	West-North-West	8
84-11-11	79	0.30	South	11
84-11-14	93	1.17	East	9
84-11-17	35	0.75	West-North-West	11
84-11-20	61	0.60	South-South-East	14
84-11-23	20	0.18	South	8
84-11-26	62	1.42	North	11
84-12-02	62	0.33	West-North-West	4
84-12-08	30	0.23	South	5
84-12-11	49	0.93	North-North-West	11
84-12-29	28	0.05	West-North-West	7
85-01-01	32	0.14	South	4

Appendix B continued

Date of Sample	T.S.P.($\mu g/m^3$)	Lead ($\mu g/m^3$)	Wind Direction	Wind Speed (Knots/Hour)
85-01-04	25	0.46	West	8
85-01-07	23	0.39	North-West	15
85-01-11	32	0.15	North-West	6
85-01-13	31	0.43	North-North-West	16
85-01-19	47	0.22	North-West	14
85-01-22	51	0.15	West	8
85-01-25	28	0.39	West-North-West	9
85-01-28	32	0.32	South	5
85-01-31	86	0.44	West	6
85-02-03	34	0.15	West	7
85-02-06	55	0.62	South-South-East	14
85-02-09	34	0.18	East-South-East	9
85-02-12	54	0.49	South-South-East	8
85-02-15	34	0.49	South-South-East	10
85-02-19	50	0.46	South	7
85-02-22	35	0.39	North-West	9
85-02-24	36	0.11	South	12
85-02-27	167	0.53	South	12
85-03-02	39	0.10	North-North-West	10
85-03-05	124	0.23	South	6
85-03-08	49	0.22	West-North-West	8
85-03-14	341	0.88	North	5
85-03-17	108	0.58	South	8
85-03-23	178	0.15	East-South-East	9
85-03-26	126	0.72	North	10
85-03-29	639	1.14	North-North-East	10
85-04-04	513	1.09	North	4

Appendix C: Comparison between Weston School sites CB3 and CB5 for total suspended particulate and lead concentrations.

Date of	CB3 (Roof)		CB5 (Ground)	
Sample	T.S.P.($\mu g/m^3$)	Lead ($\mu g/m^3$)	T.S.P.($\mu g/m^3$)	Lead ($\mu g/m^3$)
84-01-11	90	0.29	264	0.86
84-01-17	25	0.15	45	0.23
84-01-24	25	0.12	52	0.26
84-01-29	24	0.16	35	0.19
84-02-13	27	0.15	49	0.28
84-02-18	23	0.25	46	0.50
84-02-24	95	0.33	693	2.21
84-02-28	89	0.46	322	1.22
84-03-06	116	0.22	330	0.62
84-02-13	74	0.22	372	0.77
84-03-17	35	0.11	65	0.25
84-03-25	74	0.12	193	0.24
84-04-18	238	0.44	970	1.69
84-04-21	87	0.13	237	0.43
84-04-24	76	0.15	224	0.54
84-06-20	71	0.18	82	0.52
84-06-23	33	0.14	281	0.83
84-06-16	36	0.13	97	0.81
84-07-29	90	0.43	108	0.62
84-07-05	44	0.17	134	0.96
84-07-08	70	0.51	67	0.39
84-07-11	23	0.08	88	0.55
84-07-14	31	0.42	60	0.26
84-07-20	96	0.84	136	0.65
84-07-23	50	0.19	89	0.17

Appendix D: Site CB3 - Total suspended particulate and lead concentrations versus wind direction.

TSP ($\mu g/m^3$)				Lead ($\mu g/m^3$)			
West	North	East	South	West	North	East	South
25	23	90	24	0.15	0.25	0.29	0.16
25	90	95	27	0.12	0.46	0.33	0.15
76	116	238	35	0.15	0.22	0.44	0.11
23	74	67	74	0.08	0.22	0.25	0.12
31	33	51	87	0.42	0.14	0.30	0.13
89	36	96	71	0.46	0.13	0.84	0.18
43	44	48	90	0.22	0.17	0.30	0.43
26	50	63	70	0.24	0.19	0.18	0.51

Appendix E: Site CB5 - Total suspended particulate and lead concentrations versus wind direction.

TSP ($\mu g/m^3$)				Lead ($\mu g/m^3$)			
West	North	East	South	West	North	East	South
45	46	264	35	0.23	0.50	0.86	0.19
52	322	693	49	0.26	1.22	2.21	0.28
88	330	970	65	0.55	0.62	1.69	0.25
60	372	141	193	0.26	0.77	0.86	0.24
222	281	225	237	0.46	0.83	0.51	0.43
363	97	57	82	0.42	0.81	0.90	0.52
145	134	79	108	0.13	0.96	0.87	0.62
238	89	247	67	0 24	0.17	2.00	0.39

Appendix F: Comparisons between sites - total suspended particulate ($\mu g/m^3$).

	Sites					
Date	CB3	CB5	9118	9119	9102	9120
84-04-18	238	970	67	188	75	187
84-04-24	76	224	54	107	75	56
84-06-23	33	281	23	60	37	18
84-06-29	90	108	43	114	44	44
84-07-05	44	134	21	63	46	22
84-07-11	23	88	60	76	57	70
84-07-23	50	89	27	54	56	37

Appendix G: Comparisons between sites - Lead ($\mu g/m^3$).

				Sites		
Date	CB3	CB5	9118	9119	9102	9120
84-04-18	0.44	1.69	0.17	0.27	0.21	0.39
84-04-24	0.18	0.54	0.11	0.20	0.16	0.09
84-06-23	0.14	0.83	0.09	0.14	0.27	0.06
84-06-29	0.43	0.62	0.12	0.25	0.06	0.16
84-07-05	0.17	0.96	0.08	0.12	0.29	0.11
84-07-11	0.08	0.55	0.41	0.28	0.33	0.19
84-07-23	0.19	0.17	0.09	1.51	0.35	0.18